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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Appl. No. : 10/600,904  
Applicants : Robert Sigurd Nelson, William Bert Nelson  
Filing Date : June 20, 2003  
Examiner : Irakli Kiknadze  
Art Unit : 2882  
Title : DEVICE AND SYSTEM FOR IMPROVED IMAGING IN NUCLEAR  
MEDICINE AND MAMMOGRAPHY

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

September 24, 2004

Dear Mr. Kiknadze:

In response to the Office Action post marked September 9, 2004, please see the following remarks for application 10/600,904.

**REMARKS**

In the office action post marked September 9, 2004 the Examiner rejected claims 57-59 based on Walters.

Applicants will address first the rejection of claim 57 as being anticipated by Walters. Walters describes a dual-energy CT systems which is based on obtaining two arrays of data values representative of beam attenuation at two different energy levels. The two distinct (high and low) energy levels  $S_1$  and  $S_2$  are the result of two different x-ray tube voltage levels (high and low KVPs such as 120 KVP and 70 KVP). That is, two distinctly different, broad bandwidth x-ray spectra. Furthermore the data values are in the form of analog signals that are proportional to the detected beam intensities. See Col. 13: lines 56-68, col. 14: 1-12. The data are combined from the two scans to synthesize two images (photoelectric and Compton or equivalently bone and tissue). The calibration procedure Walters refers to in col. 10: lines 16-34 requires the development of a table of photoelectric and Compton values in terms of intensities  $I_1$  and the ratio  $I_2/I_1$ . Walters performs air scan at two energy (KVP or tube voltage levels) to develop high and low energy beam profiles. These are broad bandwidth x-ray beam spectra and the detectors are analog (integrators). There is no energy resolution!

Walters has described a means of calibrating a CT detector using two different (High and Low KVP) x-ray beams for dual energy imaging. The CT detector is analog and therefore lacks energy resolution for individual photons. The analog signals are

proportional to the intensities of the x-ray beams and energy distributions that reach the detectors. The “in air” calibrations to develop high and low energy (KVP) beam profiles only measures intensities. The two different KVP x-ray beam images cannot be acquired simultaneously (either separate scans are needed, the voltage and amperage must be altered between pulses, or a filter must be rotated into and out of the beam path). Furthermore the application of this dual energy technique is restrictive in terms of High and Low KVP beams ( $S_1$ ,  $S_2$ ) that can be used (see col. 6, lines 50-62).

The inventors, on the other hand, describe employing a x-ray detector capable of measuring the energies of photons. This means that the detector can measure not only how the intensity of the beam varies spatially but also how the energy spectrum of the x-ray beam varies spatially. In other words, the intensity for each energy bin in the beam spectrum can be measured and it can be measured as a function of position (spatially). This can be done with a single KVP x-ray beam. This beam spectrum data set is compared against the data set of energy and intensity versus position acquired when imaging a patient. Using a detector with energy resolution eliminates the need for two different beams (if dual energy imaging is the goal) and the associated noise and registration problems inherent in traditional dual energy imaging. This approach allows us to do tissue “spectroscopy” on a pixel-by-pixel basis (energy-dependent images). This is described in the following passages:

P 45: lines 6-8 “If the detector offers energy resolution then an additional calibration can be performed to account for energy resolution.”.

P.45: lines 21-22 “This results in a position-dependent, energy-dependent, intensity profile.”.

P.46, lines 5-13 “If the edge-on detector is capable of providing sufficient energy resolution, such as when an energy-resolving detector rather than an integrating detector is utilized, then additional information is available. Each detected photon represents the exponential attenuation properties of the filter, which in the case of mammography is breast tissue. The filter, due to its attenuation properties, modifies the local x-ray beam intensity and spectral distribution at each detector pixel. If the spectral distribution is uniform along the length of the detector then a reasonable comparison of corrected intensity and spectral content between individual pixels in the detected image can be made. What is essentially acquired is a set of overlapping “energy-dependent images” for which the energy dependence is explicitly known..

Applicants will address next the rejection of claim 58 as being anticipated by Walters.

Walters describes in col. 9, lines 2-3 a MTF that is material-dependent which is dependent on the filtered combination of photoelectric and Compton components (col. 10, lines 3-14). It is a synthesized MTF that is a mathematical combination of two different broad bandwidth x-ray beams. It represents the synthesized MTF of the final image and not just the MTF response of the detector to a specific x-ray source.

The inventors, on the other hand, describe a detector MTF(E) that is the result of direct measurements (pp.46, lines 13-18). Synthesis is not involved. This MTF(E) can be attained because the detector has energy resolution capability. Since Walters has an analog detector that can only measure intensity the MTF(E) is not important to his invention.

Applicants will address next the rejection of claim 59 as being anticipated by Walters.

Walters describes a method of calibrating two x-ray beams (with different KVPs) and then measuring the intensity profiles of the two x-ray beams with a patient present. He talks about the use of the photoelectric and Compton components (col. 10, lines 3-14; col. 13, lines 34-43, 56-67; col. 14, lines 6-25). The calibration beams and tables ( $I_1$ ,  $I_2/I_1$ ) are then used to synthesize images based on the measured intensity profiles when the patient is present.

The inventors, on the other hand, describe direct, energy-dependent measurements that only require the use of one KVP for calibration and the same KVP for evaluation of the patient. This method permits direct spectroscopy of the patient as opposed to an approximate synthesis with two very-different KVP spectrums. This method, which uses a detector with energy resolution rather than simply measuring intensity, is more straightforward to implement while providing much more detailed information than the approach of Walters.

### CONCLUSION

Applicants respectfully submit that all of the Examiner's rejections have been overcome. Applicants respectfully request that the Examiner reconsider and withdraw the outstanding rejections and allow the present application. Applicants invite the Examiner to telephone the undersigned representative if the Examiner believes that a telephonic interview would advance this case to allowance.

Respectfully submitted,

By: Robert Sigurd Nelson  
Robert Sigurd Nelson

Dated: 9-24-04

Robert Sigurd Nelson  
2922 Upshur Street  
San Diego, California 92106  
Phone (work): (619) 594-1013.  
Fax (work): (619) 594-5485.